

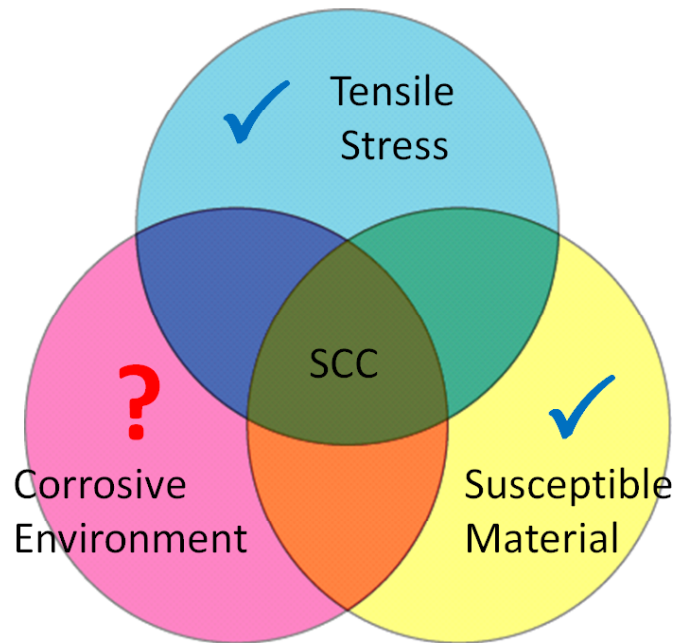
Aging Management Program Example for Stress Corrosion Cracking

Darrell S. Dunn

Meeting to Discuss the Request for Additional Information
Responses Regarding the Calvert Cliffs Independent Spent
Fuel Storage Facility License Renewal

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Stress Corrosion Cracking Background Information



**2/3 of the requirements
for SCC are present in
welded stainless steel
canisters**

- 304 and 316 Stainless steels are susceptible to chloride stress corrosion cracking (SCC)
 - Sensitization from welding increases susceptibility
 - Crevice and pitting corrosion can be precursors to SCC
 - SCC possible with low surface chloride concentrations
- Welded stainless steel canisters have sufficient through wall tensile residual stresses for SCC
- Atmospheric SCC of welded stainless steels has been observed
 - Component failures in 16-33 years
 - Estimated crack growth rates of 0.11 to 0.91 mm/yr

Regulatory Basis

- **10 CFR 72.42(a), 72.240(c):**
 - TLAAAs that demonstrate that ITS SSCs will continue to perform their intended function for the period of extended operation.
 - A description of the AMP for management of issues associated with aging that could adversely affect ITS SSCs.
- **Guidance: NUREG-1927 AMP Elements:**

1. Scope of the Program	6. Acceptance Criteria
2. Preventive Actions	7. Corrective Actions
3. Parameters Monitored/Inspected	8. Confirmation Process
4. Detection of Aging Effects	9. Administrative Controls
5. Monitoring and Trending	10. Operating Experience

AMP Element 1

Scope of the Program



NUREG-1927: The scope of the program should include the specific structures and components subject to an AMR

- Welded stainless steel dry storage canisters
 - Fabrication and closure welds
 - Weld heat affected zones
 - Locations where temporary supports or fixtures were attached by welding
 - Crevice locations
 - Surface areas where atmospheric deposits preferentially occurs
 - Surface areas with a lower than average temperature

AMP Element 2

Preventative Actions



NUREG-1927: Preventive actions should mitigate or prevent the applicable aging effects

- Aging Management Program (AMP) is for condition monitoring.
 - Preventative actions are not presently incorporated into existing dry storage canister designs
- Future designs or amendments could include
 - Surface modification to impart compressive residual stresses on welds and weld heat affected zones
 - Materials with improved localized corrosion and SCC resistance

AMP Element 3

Parameters Monitored/Inspected

NUREG-1927: Parameters monitored or inspected should be linked to the effects of aging on the intended functions of the particular structure and component

- Canister surfaces, welds, and weld heat affected zones for discontinuities and imperfections
- Size and location of localized corrosion (e.g., pitting and crevice corrosion) and stress corrosion cracks
- Appearance and location of atmospheric deposits on the canister surfaces

AMP Element 4

Detection of Aging Effects (1/2)



NUREG-1927: Define method or technique, frequency, sample size, data collection, and timing to ensure timely detection of aging effects

- Qualified and demonstrated technique to detect evidence of localized corrosion and SCC:
 - Remote visual inspection, e.g. EVT-1, VT-1, VT-3, or Eddy Current Testing (ET) may be appropriate
- Pending detection findings, sizing SCC would require volumetric methods

AMP Element 4

Detection of Aging Effects (2/2)

- Sample size
 - Minimum of one canister at each site
 - Canisters with the greatest susceptibility
- Data Collection
 - Documentation of the examination of the canister
 - Location and appearance of deposits
- Frequency
 - Every 5 years
- Timing of Inspections
 - Within 25 years of initial loading

AMP Element 5

Monitoring and Trending



NUREG-1927: Should provide for prediction of the extent of the effects of aging and timely corrective or mitigative actions

- Document canister condition particularly at welds and crevice locations using images and video that will allow comparison in subsequent examinations
- Changes to the size and number of any corrosion product accumulations
- Location and sizing of localized corrosion and stress corrosion cracking

AMP Element 6

Acceptance Criteria (1/2)



NUREG-1927: Acceptance criteria, against which the need for corrective action will be evaluated; should ensure that SSC functions are maintained

- No indications of:
 - Pitting or crevice corrosion
 - Stress corrosion cracking
 - Corrosion products near crevices
 - Corrosion products on or adjacent to fabrication welds, closure welds, and welds for temporary supports or attachments

AMP Element 6

Acceptance Criteria (2/2)

- Locations with corrosion products require additional examination for localized corrosion and/or SCC
- Size of the area affected and the depth of penetration if localized corrosion and/or SCC is identified
- Canisters with localized corrosion and/or SCC must be evaluated for continued service in accordance with ASME B&PV Code Section XI IWB-3514.1 and IWB-3640

AMP Element 7

Corrective Actions



NUREG-1927: Corrective actions, including root cause determination and prevention of recurrence, should be timely

- Supplemental inspections to determine the extent of condition at the site
- Subsequent inspections of canisters with indications
- Canisters that do not meet the prescribed evaluation criteria must be repaired or removed from service

AMP Element 8

Confirmation Process



NUREG-1927: Confirmation process should ensure that preventive actions are adequate & appropriate corrective actions have been completed & are effective

- Licensee Quality Assurance Program consistent with 10 CFR 72 Subpart G, or 10 CFR 50 Appendix B
- Ensure that inspections, evaluations, and corrective actions are completed in accordance with the Site Specific or General Licensees Corrective Action Program (CAP)
 - Extent of condition
 - Evaluation for continued service
 - Repair, replace, mitigation actions

AMP Element 9

Administrative Controls



NUREG-1927: Administrative controls should provide a formal review and approval process

- Licensee Quality Assurance Program consistent with 10 CFR 72 Subpart G, or 10 CFR 50 Appendix B
- Training requirements for inspectors
- Records retention requirements

AMP Element 10

Operational Experience



NUREG-1927: Include past corrective actions; provide objective evidence to support a determination that the effects of aging will be adequately managed so that the SSC intended functions will be maintained during the period of extended operation

- No reported cases of localized corrosion or SCC in welded stainless steel canisters
- Atmospheric deposits on canister surfaces have been observed
- Several reported cases of chloride induced SCC from atmospheric deposits observed in operating reactors (NRC Information Notice 2012-20)
- Laboratory and field test data on conditions necessary for chloride induced SCC and SCC growth rates

Acronyms

AMP: Aging management program

TLAA: time limiting aging analysis

AMR: Aging management review

ITS: Important to safety

ASME B&PV code: American Society of Mechanical Engineers Boiler and Pressure Vessel code

SCC: Stress corrosion cracking

CAP: Corrective action program

SSC: Structures systems and components

CFR: Code of Federal Regulations

VT-1: Visual Testing-1 (ASME B&PV code Section XI, Article IWA-2200)

EVT-1: Enhanced visual testing-1 (Boiling water reactor vessels and internals project, BWRVIP-03)

VT-3: Visual Testing-3 (ASME B&PV code Section XI, Article IWA-2200)